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Utilization of Canola Chaff for Feed

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UTILIZATION OF CANOLA CHAFF FOR FEED

by

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ABSTRACT

During the winter of 1984-85, a herd of pregnant cows stopped eating ammoniated Westar canola chaff after consuming about three-quarters of the pile. An attempt to repeat the situation was unsuccessful since, in this instance, the canola was completely consumed. The canola chaff increased in feed value (CP from 6.1% to 15.4%; TDN from 38% to 52%) and only contained small amounts of glucosinolate and sinapine, probably too little to affect palatability. Based on these results and some on-farm experience, we would expect a maintenance ration consisting of a properly supplemented mixture of ammoniated wheat and canola chaff to provide adequate nitrogen and energy to overwinter pregnant cows.

INTRODUCTION

During the fall of 1984 Don and Wayne Russell of Jadoway Farms near Harris, Saskatchewan, lost a large portion of their wheat chaff. This was due to a high wind which occurred immediately after threshing, and before the chaff could be collected from the field. Because they were then short of feed they collected chaff from Westar canola to supplement their wheat chaff. This chaff consisted almost completely of split pods.

The Russell brothers had been ammoniating wheat chaff successfully for several years and decided to ammoniate the canola chaff as well. When they began feeding this ammoniated material, the pregnant beef cows appeared to prefer the ammoniated canola chaff to all other feedstuffs they were using. However, when they reached a certain point in the chaff pile (they were feeding with an electric wire) the animals refused the ammoniated canola chaff completely. One possible reason for this was that, during the ammonia application, a narrow diameter pipe was used which did not apply ammonia directly to the far side of the chaff pile. One supposition was that ammonia affected a bitter component in the chaff and where little ammonia was applied, the bitter component was not changed, resulting in reduced palatability.

The feed value of canola chaff should not be a reason for its lack of acceptance since it was quite nutritious compared to other crop residues. Canola chaff responds well to ammonia treatment. However, the results of the field ammoniation showed a good improvement in crude protein (CP) but a relatively poor improvement in digestibility (OMD, TDN) (Table 1).

A computer search of the literature since 1972 uncovered nothing whatsoever about feeding rape or canola residues of any kind in North America. Chomyszyn et al. (1972) stated that rape straw was not used as an animal feed in Poland due to its hardness, high fiber content and low digestibility. At that time it was only used for bedding or was plowed into the fields. There were only a few other references pertaining to feeding forage rape and rape silage in Europe.

Table 1. Effect of ammonia treatment on the feed value of canola chaff at Jadoway farms in 1984.

Treatment	Crude Protein	Phosphorus	Ash	OMD	TDN
		%			
Untreated	10.8[a1]	0.16	8.3	51.4[a]	52.0[a]
Ammoniated - Lab.	20.8[b]	0.17	10.1	63.8[b]	64.7[b]
Ammoniated - Field	17.1[b]	0.13	8.9	56.7[a]	57.4[a]
Significance of Treatment Effect	**	NS	NS	**	**
Alfalfa hay mid bloom	17	0.23	10	63	64
Clover hay Ladino	21	0.32	9	66	67
Brome grass hay	10	0.23	9	59	60

OMD - Organic matter digestibility
TDN - Total digestible nutrients
The results for hay quality were obtained from a feed composition table for 1985-86 in Feedstuffs, August, 8, 1985, pp19.

[1] means within a column with the same letter in the superscript are not significantly different (P=0.05) according to Duncan's multiple range test.

Some information about feeding canola chaff was obtained by contacting Saskatchewan Agriculture Livestock Specialists. Some producers found untreated canola chaff to be a suitable feed while others deemed

it to be unpalatable as it was not consumed well. L. Redekop, now of the Saskatoon area, had fed an ammoniated mixture of cereal chaff and canola chaff quite successfully in previous years. S. McCarthy of Meota, Saskatchewan, fed a small amount of untreated canola chaff in the late fall of 1985 without encountering a problem. R.J. Sparling, the livestock specialist at North Battleford, reported that frozen whole canola had been fed in his region and that he was not aware of any problems arising from this action.

The objectives of this project were to:

(1) evaluate the nutritional value of ammoniated canola chaff
(2) determine the animal acceptability of ammoniated canola chaff and obtain the producers observations about their performance.
(3) attempt to determine the reason the animals at Jadoway Farms stopped consuming ammoniated canola chaff.
(4) determine the grain to chaff ratio of canola.
(5) measure extent of reaction at different places in the stack so as to measure the consistency of ammonia penetration and reaction with canola chaff.

MATERIALS AND METHODS

A 26 tonne pile of Westar canola chaff was moistened with water to give a resultant moisture content of about 20%, and covered with plastic on the farm of Leo Redekop near Saskatoon, Saskatchewan on October 25, 1985. Anhydrous ammonia (3.5%) was added through 1 inch diameter pipes containing 5-3/8 inch holes. Six samples of canola chaff were taken from across the face of the pile prior to ammoniation and shortly after

the beginning of feeding on January 6, 1986. Further samples were taken in the same manner on January 30 and February 26, 1986, as the animals ate their way through the chaff pile. The final samples were taken when there was about 1.2 metres of the width of the chaff pile left. Ammoniation of other piles containing wheat chaff indicated that ammonia did not reach the last hole in the pipe during its addition. The color change in the chaff showed distinctly where ammonia had come into contact with the chaff. Therefore, it was assumed that the same situation which occurred at Jadoway Farms would occur here, and the canola chaff was to be sampled for the last time when the cows stopped consuming it.

Fourteen pregnant cows were put on the ammoniated canola chaff on January 6, 1986. The cows consumed the canola chaff reasonable well but not as well as other cows consumed ammoniated wheat chaff. These cows received 1.8 kg of grain per head per day in addition to the canola chaff while those on wheat straw only received a supplement of 0.9 kg of grain per head per day.

All samples were air dried and processed for analysis at the University of Saskatchewan Feed Testing Laboratory for moisture, CP, ash and in vitro digestibility. In addition, selected samples were to be analyzed for glucosinolates and sinapine at the Saskatoon Experimental Station of Agriculture Canada.

RESULTS AND DISCUSSION

All the cows consumed the ammoniated canola chaff quite well until about the middle of March when some of them began to calf. The cows were taken off the canola chaff at calving. Although the ammoniated

canola chaff was completely cleaned up, the animals left on it to the end did not consume it as well during the last few weeks as they had at the beginning. Unfortunately we were not informed of this until all the chaff was gone or we would have taken one more set of samples.

The feeding trial was complete about mid April and, although the producer did not feel the animal acceptance was quite as good as it was for ammoniated wheat chaff, all the ammoniated canola chaff was consumed without a serious problem. The producer was happy with the condition of the cattle at calving time. All the cows on the ammoniated canola chaff calved and the calf weights were normal. The results of pregnancy tests conducted on these cows during the fall of 1986 were also normal.

Since there is no present market for canola chaff, Table 2 estimates the cost of collecting and ammoniating a forty tonne pile of chaff, and feeding a canola chaff ration to pregnant cows. The cost of feeding ammoniated canola chaff is quite similar to the cost of feeding ammoniated wheat chaff, while the cost of a brome-alfalfa hay ration, with hay valued at $80 per tonne, is approximately $0.80 - $0.85 per head per day.

Table 2. The cost of feeding ammoniated canola chaff.

Collection cost ($/tonne)	18
Ammoniation cost ($/tonne)	14.6
Rolled grain ($/tonne)	132
Estimated intake of canola (Kg/head/day)	11.8
Estimated intake of rolled grain (Kg/head/day)	1.8
Estimated feed cost ($/head/day)	0.61

The results showing the effect of the ammonia treatment at specific

times after ammoniation or at specific locations in the pile, were as expected (Table 3). Since the animals did not refuse the feed, and the samples taken on February 26/86 had been in contact with ammonia for the longest period of time, it was not surprising that they showed the best improvement in CP and digestibility. The mean digestibility of these samples is significantly greater than the mean for untreated samples and those collected on January 6, 1986.

Table 3. Effect of location and ammoniation on the feed value of canola chaff. (Results expressed on a dry matter basis).

Sampling Date	Crude Protein %	Ash	OMD	TDN
Oct. 25/85[1]	6.1[a2]	7.2	38[a]	38[a]
Jan. 6/86	14.9[b]	6.5	48[b]	48[b]
Jan. 30/86	15.0[b]	6.3	49[bc]	50[bc]
Feb. 26/86	15.4[b]	9.2	51[c]	52[c]
Significance of Treatment Effect	**	NS	**	**

1. Untreated control from face of chaff pile.
2. Means with the same superscript in the same column are not significantly different at the 5% level according to Duncan's multiple range test.

OMD - Organic matter digestibility
TDN - Total digestible nutrients

Table 4 shows that canola chaff appears to be a good quality residue and responded better to ammonia treatment than crested wheat grass or Russian wild rye hays which would be considered medium quality hays if harvested at the proper maturity.

Table 4. A comparison of the ammoniation of canola chaff with the ammoniation of Russian wild rye and crested wheat grass hays harvested on June 23, 1978.

Forage	Treatment	CP(%)	Ash(%)	OMD(%)
Crested wheat grass*	Untreated	10.3	5.1	55
	Ammoniated	19.7	5.1	55
Russian wild rye*	Untreated	9.4	7.0	49
	Ammoniated	18.5	7.0	53
Canola chaff	Untreated	6.1	7.2	38
	Ammoniated	15.0	6.5	50

*Kernan et al 1980.

The glucosinolate analysis, conducted by Canada Agriculture, on some of the canola samples indicated that the concentrations of glucosinolates in canola chaff are very low and are not significantly affected by ammoniation (Table 5).

Agriculture Canada scientists were not in a position to conduct a sinapine determination at this time and the analysis was carried out at the Saskatchewan Research Council (SRC).

Table 5. Glucosinolate concentrations in untreated and ammoniated canola chaff.

Treatment		Glucosinolates (micromoles/g) Butenyl-	Hydroxybutenyl-
Untreated	1.	0.13	0.08
	2.	0.23	0.09
Ammoniated			
Jan. 6/86	1.	0.15	0.07
	2.	0.21	0.06
Jan. 30/86	1.	0.54	0.08
	2.	0.07	0.07
Feb. 26/86	1.	0.08	0.06
	2.	0.19	0.10

Canola is known to contain sinapine, the choline ester of sinapic acid. It is considered to be responsible for the bitter taste which canola meal is reputed to have. The procedure used for this separation and analysis was that of Ismail and Eskin (1979). Sinapine and the neutral phenolics from canola were extracted by refluxing ground canola chaff in acetone-water and then sinapine was separated from the neutral phenolics on a neutral aluminum oxide column. The neutral phenolic fraction contains esters and glucosides of sinapic acid which could interfere with the sinapine determination (Fenwick 1981). The major drawback of this method is the loss of sinapine both on the column and into the neutral phenolic fraction. The sinapine content was determined by colorimetry following treatment with titanium tetrachloride in concentrated hydrochloric acid at an elevated temperature.

The results in Table 6 do not show much change in the sinapine content before and after ammoniation and it may be that ammonia treatment has no effect on sinapine. However the ammonia treatment may also hydrolyze other sinapic acid esters as well as sinapine, if they are present, and convert them to ammonium sinapate or sinapamide. Presently we do not know whether or not ammonium sinapate or sinapamide would be separated from either the sinapine fraction or the neutral phenolic fraction on the neutral aluminum oxide column. Therefore these results do not show whether or not ammonia has an effect on sinapine.

Table 6. Sinapine content in untreated and ammoniated canola chaff.

Canola Chaff	Sinapine Fraction (%)	Sinapine in the Neutral Phenolic Fraction (%)
Untreated Chaff	3.42	0.52
Ammoniated Chaff		
-Jan. 6/86	3.98	0.00
-Jan. 30/86	4.01	0.00
-Feb. 26/86	3.26	0.91

Solving this problem would require developing a method of separating free sinapic acid, ammonium sinapate and sinapamide from the extract before developing the color for the sinapine analysis, and this was beyond the scope of this project.

Three members of SRC staff tasted the untreated canola pods from Redekop's farm and did not observe any bitterness. It is possible that the canola chaff from Jadoway Farms in 1984 contained a bitter component while the canola chaff tested at Redekop's farm in 1985 did not. Although both were Westar canola, there was a difference between them.

The untreated canola chaff from Jadoway Farms filled the car with a sweet and unpleasant odour, distinctly noticeable before transporting the samples to SRC. This odour was not present when transporting the untreated canola chaff from Redekop's farm to SRC.

The chaff separation of canola to determine the seed-chaff ratio was to be determined on canola grown by the Crop Science Department of the University of Saskatchewan. Unfortunately, their 1985 crop of canola was a failure and this portion of the project could not be completed. However, some separations were conducted previously on several crops including canola (Coxworth et al 1982) (Table 7). The yields of chaff (pods) were quite acceptable compared to the chaff yields from the cereal crops.

Table 7. Yields of seed and separated crop residues of several annual crop species harvested at the mature seed stage at Saskatoon in 1981.

Crop Species	Cultivar	Yield (kg/ha)			
		Total Crop	Seed	Chaff (Pods)	Remaining Residue
Canola	Candle	3100	750	330 (44)*	2020
Canola	Regent	5970	1490	340 (23)	4140
Mustard	Domo	6950	2440	510 (21)	4000
Wheat	Neepawa	5280	2310	520 (23)	2450
Barley	Bonanza	5630	2620	70 (3)	2940
Oats	Hudson	6380	3050	410 (13)	2920

*The figures in parenthesis are the % chaff yield based on the seed yield.

CONCLUSIONS

1. Since animal rejection was not observed during this feeding trial, we must conclude that either the ammonia treatment removed any palatability problems from the canola chaff, or they did not exist in the first place.

2. Although the cattle did not find ammoniated canola chaff as palatable as ammoniated wheat chaff (Redekop 1986) they performed very well on this ration. This canola chaff was inferior to that used at Jadoway Farms but responded much better to the ammonia treatment.

3. Based on the results of this study, we would expect a mixture of ammoniated wheat and canola chaff supplemented with vitamins, minerals and some energy depending upon the weather conditions, to be the basis of an economical maintenance ration for pregnant beef cows.

4. In this feeding trial no toxic symptoms whatsoever were observed. However, we would have some reservations about feeding high quality ammoniated canola chaff, supplemented only with grain, as a maintenance ration. Weiss et al. (1986) reported neurological symptoms exhibited by sheep and cattle fed ammoniated hay, and, based on its nutritional value, canola chaff could fall into the category of a medium quality hay. The problem arises when hay containing soluble sugars is treated with ammonia at temperatures above $70^{o}C$. Although none of these symptoms have been observed in Western Canada, the problem requires further investigation before this process can be recommended for the treatment of canola chaff to be used as the sole roughage in a maintenance ration for pregnant cows.

RECOMMENDATIONS

Since the palatability problems encountered at Jadoway Farms were not encountered in this study, a more comprehensive investigation would be advisable. An intake, digestibility and maintenance trial to compare untreated and ammoniated canola chaff with a standard maintenance ration such as a brome-alfalfa hay should solve this problem and also determine the nutritional and economic value of canola chaff as a maintenance ration. Studies to test for the presence or absence of the toxic factors mentioned previously should also be done.

SUMMARY

During the fall and winter of 1984-5 gestating cows were fed ammoniated Westar canola chaff on Jadoway Farms near Rosetown, Saskatchewan. The acceptance of this feed by the animals was excellent until they reached a certain point in the chaff pile when they stopped consuming the ammoniated canola chaff completely. One supposition was that the ammonia reduced or eliminated a bitter taste in the chaff which improved its palatability. There was reason to believe that the ammonia had not reached the far side of the chaff pile due to using a small diameter pipe with too many holes in it.

In order to determine why consumption of the chaff stopped abruptly, a forty tonne pile of Westar canola chaff was moistened with water and treated with 3.5% anhydrous ammonia on the farm of Leo Redekop near Saskatoon. A narrow pipe was used to add the ammonia which had not allowed the liquid ammonia to get to the last hole in the pipe when ammoniating a pile of wheat chaff. Control samples were taken prior to am-

moniation and three sets of ammoniated samples were taken as the animals ate their way across the width of the stack. The chaff showed an increase of 6.1% to 15.4% in crude protein and 38% to 52% in total digestible nutrients when comparing the controls to the last samples taken. The animals consumed the chaff supplemented with 1.8 kg grain per head per day quite well, and were in good condition at calving time. Their consumption of the ammoniated canola chaff did not appear to be quite as good as the consumption of ammoniated wheat chaff. This consumption appeared to be reduced at the tail end of the trial, but even so, the ammoniated canola chaff was completely eaten.

Analysis of the chaff indicated that the glucosinolate content was quite low and was not affected by ammoniation. The total sinapine content ranged between 3% and 4%. There was no evidence to indicate that ammoniation had any effect on the sinapine content. Also, the untreated chaff did not taste bitter when tasted by three Saskatchewan Research Council employees.

Although there were no toxic symptoms observed in any of the animals used for this trial, it is recommended that canola chaff be ammoniated and fed as a mixture with cereal chaff. Canola chaff is approaching a medium quality hay in feed value. Reports from the United States indicate that toxic compounds causing a neurological disorder have been observed in animals consuming medium to good quality hays and greenfeed treated with ammonia. No such problems have originated in western Canada that we are aware of.

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